PART D

DISPOSAL SITE CHARACTERISTICS

SECTION D.1

GENERAL

D.1 GENERAL

D.1.1 INTRODUCTION AND PURPOSE

In order to obtain new or updated WDRs from the RWQCB, an operator must supply information on a site's physical characteristics in accordance with 27 CCR, Section 21750. This section provides the required information and includes site-specific and regional data on topography, climatology, geology, soil characteristics, faulting and seismicity, and water resources (e.g., hydrology). Tables 1 and 2 provide a cross-reference index of the applicable Title 27 requirements and the various subsections in which they are addressed. Much of the information included herein has been summarized from more detailed reports which contain additional information regarding specific project elements. Where appropriate, these reports are referenced and are presented either as an appendix to the report or are available upon request. In all cases, these reports are listed in Section D.6 of the JTD.

The purpose of compiling the site characterization information is to provide the RWQCB with adequate site data to determine potential negative impacts to the public and surrounding environment. For example, information regarding the site and regional geology may influence the site's natural waste containment characteristics. Similarly, faulting and seismicity data provide information from which to assess potential geologic hazards such as earthquakes, which in turn can influence a landfill's waste containment system design. The information presented will be considered by the RWQCB in their evaluation of the proposed landfill design, operation and environmental monitoring activities.

D.1.2 GENERAL SETTING

The proposed GCLF is located in northern San Diego County approximately three miles east of I-15 and two miles southwest of the community of Pala (Figure 1). The site is adjacent to SR 76, the San Luis Rey River and lies along the western slope of Gregory Mountain. The GCLF refuse footprint is located south of the river and above the floodplain.

The GCLF will be situated on an approximately 1,770-acre property of which approximately 308 acres will be used for landfill activities and 183 acres will be used specifically for refuse disposal. Figure 2 presents the layout of the proposed landfill.

D.1.3 LAND USE

Current land use for the proposed GCLF is discussed in Section B.1.2.4 and shown on Figure 3. The area is primarily rural with agricultural uses on the valley floor. South of the river, there are open fields for dairy cows. Scattered food crops and orchards also surround the landfill property. Directly south of the landfill are citrus and avocado orchards. Other than family pets, mainly cows are within the vicinity of the landfill property. The number and location of structures within one mile of the perimeter of the unit is shown on Figure 5.

As discussed in Section B.1.9, the ultimate post-closure end use for the GCLF will be undeveloped open space. The GCLF is not expected to affect the future development plans of the Palomar Aggregate Rock Quarry, the Calmat-Pala Aggregate Mining, the Pala Band of Mission Indians Gaming Facility, the gas station west of I-15, Dulin Ranch, Lake Ranch Viejo, Brook Hills, Campus Park Specific Plan which includes a 422-acre mixed-use development with 32 acres of industrial uses and 17 acres of commercial uses, or the Sycamore Ranch project. In accordance with Proposition C, the project will dedicate a minimum of 1,313 acres of the project as permanent open space for long-term preservation of sensitive habitat and species.

SECTION D.2

SITE TOPOGRAPHY

D.2 SITE TOPOGRAPHY

D.2.1 INTRODUCTION

Topographic information is provided in the following sections as required under 27 CCR. Topographic information was obtained from an aerial survey flown in 1991 (Figure 27A). The proposed final grading plan for the landfill was prepared in accordance with 27 CCR, Sections 21090(b) and 21142(a) and is shown on Figure 9.

D.2.2 TOPOGRAPHIC SETTING

The GCLF occupies a portion of the San Luis Rey River valley and surrounding canyon, ridge, and mountain systems. Natural surface elevations on the property range from approximately 1,200 feet above mean sea level (amsl) at the head of the canyon at the south, to 300 feet amsl at the mouth of the canyon in the San Luis Rey River drainage. Much of the canyon is steep, rugged terrain containing numerous boulder outcrops on the eastern side with only a few isolated boulders on the west canyon wall. The canyon flattens somewhat at the mouth where it meets the alluvial deposits of the San Luis Rey River drainage. A prominent knoll extends into the drainage channel on the west side of the canyon mouth.

The existing slopes on the lower area of Gregory Canyon are approximately 5:1 (horizontal:vertical), becoming 2:1 at the east edge of the landfill footprint, and are 1:1 and steeper on the upper part of the eastern slope. The western flank of the canyon is defined by a rounded ridgeline, with rather uniform slopes at inclinations of 2:1 to 3:1. Topography within one mile of the site is presented on Figure 30A. Additional topographic information can be found in the Geologic, Hydrogeologic and Geotechnical Investigation Report included in Appendix C.

D.2.3 FLOODPLAIN

As required by 27 CCR, Section 21750, an operator must determine whether the facility is located within a 100-year floodplain. The proposed landfill footprint and borrow/stockpile areas are not located within the designated boundaries of a 100-year floodplain (Reference: FEMA Flood Insurance Rate Maps, June 1997) (Figure 30B). The access road/bridge would be located within the designated boundaries of the 100-year and 500-year floodplains. However, the lowest elevation of the access road/bridge would be 312.0 while the 100-year floodplain at the upstream face is 310.7 feet. Therefore, the access road/bridge is designed to be above the highest record elevation of the 100-year floodplain so that no significant flooding impacts would occur during operations. The landfill perimeter drainage network would collect all surface drainage entering onto the site. Surface water run-on would then be directed to the on-site desilting basins which will discharge to the natural drainage course and into the San Luis Rey River.

SECTION D.3

SITE CLIMATOLOGY

D.3 SITE CLIMATOLOGY

D.3.1 GENERAL

The climate of San Diego County can be best characterized by warm, dry weather during the summer months and cool, seasonal wet weather during the winter months. A semi-permanent, high-pressure cell located over the Pacific Ocean dominates the area. This high-pressure cell maintains clear skies for much of the year. Seasonally, summer temperatures typically average between the low 60s° and low 80s° F. Winter temperatures range between the low 40s° and low 60s° F.

D.3.2 PRECIPITATION

The rainy season at the GCLF extends from November through April and the mean annual rainfall for areas surrounding the GCLF is approximately 16 inches. A minimum yearly total of 4.40 inches and a maximum yearly total of 24.79 inches is estimated for the GCLF. Available evapotranspiration data for Escondido indicate the mean is 4.84 inches, while the minimum (2.52 inches) occurs in December and the maximum (7.33 inches) occurs in July.

A hydrologic evaluation was performed for the site to provide sizing and location information for the site's storm drain facilities. The hydrologic analysis was conducted using the Rational Method Computer program (in accordance with the San Diego Manual Criteria) to determine the peak flows discharged from the Gregory Canyon watershed under pre-developed conditions. For computer modeling, the watershed (i.e., tributary area) was divided into six sub-basins. The model simulated a 100-year recurrence, 24-hour storm to obtain a peak discharge rate. A run-off coefficient of 0.4 was used for the pre-development analysis since the landfill and surrounding areas are currently in a natural state. The resulting peak flow rate for the pre-developed condition is approximately 765 cubic feet per second (cfs). The program also determined that the post-development peak flows from the site would be approximately 807 cfs, which is a minimal increase of 42 cfs or less than six percent over the flow rate for pre-development conditions.

Figure 28A shows the isohyetal contours for the proposed project and surrounding area in accordance with 27 CCR, Section 21750 (e)(1).

The run-on and run-off control systems at the GCLF are designed to intercept and convey the calculated 24-hour, 100-year storm event water volumes to desilting basins prior to discharge into off-site natural drainage courses. For more information regarding surface water control, refer to Section C.2.8.

D.3.3 WIND

Figure 28 shows the annual wind speed and directions as recorded at the nearest meteorological station. As indicated, predominant winds are from the west quadrant with an annual mean speed of 6.60 miles per hour (see Figure 28). Winds from the southwest and west-northwest are also common. Weather data is recorded at the McClellan-Palomar Airport.

Locally, the airflow within Gregory Canyon results from a combination of regional wind patterns, subregional land/sea breezes and local up-canyon/down-canyon flows. The land/sea breeze is primarily easterly/westerly while the canyon topography is oriented north/south. Winds within the canyon are predicted to be light due to the conflicting perpendicular flow regimes. Wind directions in the canyon normally follow a pattern of weak south to north drainage at night, a light sea breeze from the south-southwest during the morning, and a strengthening onshore flow from the northwest beginning mid-day and continuing until late evening. The ridgeline east of Gregory Canyon also protects the canyon from the occasional Santa Ana winds that blow from the northeast.

SECTION D.4

GEOLOGY

D.4 GEOLOGY

As required by 27 CCR, Section 21750, the geologic and seismic setting of the GCLF are discussed in the following sections.

D.4.1 REGIONAL GEOLOGY

The GCLF is located in the Peninsular Ranges geomorphic province, which is characterized by northwesterly trending mountain ranges and intervening valleys. This geomorphic province extends from the Los Angeles Basin into Baja California, Mexico. Major drainage systems generally traverse the province in a westerly direction and in northern San Diego County includes, from north to south, the Santa Margarita, San Luis Rey and San Dieguito rivers. The proposed landfill is located in Gregory Canyon, a north-draining tributary canyon of the San Luis Rey River valley, the major east-west drainage in the northern part of San Diego County.

Throughout the northern part of San Diego County, there are exposures of Mesozoic intrusive crystalline rocks of the Southern California batholith, and metamorphosed screens of pre-batholithic rocks. These granitoid and older metamorphic rocks have been weathered to various degrees, and are often covered by residual soils, colluvium, or alluvium. The colluvial deposits are typically found along the base of slopes and are formed as the result of the downslope movement of rock and soil by the force of gravity. The alluvial deposits are found to some degree in most drainages, with deposits of considerable thickness present in major river valleys.

The tectonic regime of the region has changed significantly between the time of emplacement of the intrusions of the Southern California batholith and the present. During the Mesozoic, a subduction zone was active off the coast of California. The resulting heating of the crust creates an extensional regime perpendicular to the direction of subduction, which to some extent controls the location of individual intrusions and dikes stemming from these intrusions. In the case of the Mesozoic Southern California batholith, the direction of minimum stress would have been parallel to the direction of subduction (to the northeast), and dikes would have a preferential strike orientation to the northwest, perpendicular to the direction of minimum stress.

Tectonic conditions changed during the Cenozoic, when the East Pacific Rise reached the subduction zone, and the convergent margin was replaced by the transform margin of the San Andreas fault system. Transform, strike-slip motion started between 25 and 20 million years ago in the San Diego region (Atwater, 1970), and since then the tectonic "grain" of the Peninsular Ranges province has been dominated by strike-slip faulting along northwest-trending faults like the San Andreas, San Jacinto, Elsinore, and Rose Canyon faults. The Elsinore fault zone runs about six miles northeast of Gregory Canyon, and is thus the closest of these large structural discontinuities to the site. Like the rest of the mentioned faults, the Elsinore fault zone is the result of the right-slip motion between the North American and Pacific plates.

Of immediate interest to the structural setting of Gregory Canyon is the fact that the "block" between the Elsinore fault zone to the northeast and the Rose Canyon fault zone to the southwest is under a shear stress regime. In effect, the area between both fault zones is being "wrenched" clockwise by the relative motion along these faults. Under these conditions, north-oriented extensional fractures would form. This is the most likely explanation for the predominance of north-striking fractures on the site, and for the dominant orientation of topographic lineaments in the region.

D.4.2 SITE GEOLOGY

Several geologic units occur within the project site (Figure 29). In the lower portions of Gregory Canyon, a thin veneer of unconsolidated residual soils, colluvial, and alluvial deposits mantles a substrate of weathered tonalite. The topographic highs bounding the canyon are formed by igneous intrusive and metamorphic rocks with varying degrees of weathering. The following subsections describe in detail the geologic units that are exposed at the site.

Surficial Soils

According to Woodward-Clyde (1995), the topsoil units encountered in the area vary in thickness from about six inches to three feet, and are composed of silty sand, silty sand with clay, and silty sand with cobbles and boulders. In general, one would expect the steeper, upper slope area of the landfill site to have slightly thinner soil accumulations than the intermediate or lower slope areas. Underlying the topsoil are residual soil horizons or weathered rocks. The grading plan calls for removal of surficial soils over the entire footprint of the landfill.

Alluvium

Two alluvial units have been mapped at lower elevations, near the mouth of Gregory Canyon (Figure 29). The younger unit, Qal-1, is formed by overbank deposits from the active San Luis Rey River channel, which are interbedded with channel deposits from the Gregory Canyon drainage. These deposits are relatively thin and contain gravels, cobbles and boulders, supported by a sandy silt matrix. The older alluvial subunit, Qal-2, is a terrace remnant of older alluvium from the Gregory Canyon drainage.

The alluvial wedge pinches out to the south, before reaching the footprint of the proposed landfill development. The wedge thickens to the north until it eventually merges with the channel deposits of the San Luis Rey River. Near the mouth of the canyon, well GMW-2 traversed through a 50-foot section of alluvial deposits before reaching the underlying bedrock.

Colluvium

Colluvium forms a veneer over most of the surface of the proposed landfill site. In most instances, it consists of silty sand with rock fragments that range in size from gravel to very large boulders. Finer-grained deposits, largely devoid of rock fragments, were encountered in test pits located at the southern end of the canyon (Figure 29). In this area, older colluvium, consisting of clayey sand to sandy clay with varying contents of rock fragments and slight to moderate cementation was encountered.

Rock fragments exposed at the surface of the colluvial veneer vary from gravel- to boulder-size material. Boulders of leucogranodiorite, some in excess of 20 feet in maximum dimension, are present along much of the eastern sideslopes.

The thickness of the colluvial deposits in the project area is highly variable. Cross-section interpretations by Geraghty & Miller (1990) show thickness variations from 2 to 50 feet (see Plate 3 in Appendix C). The upper slope area is likely to be underlain by thin colluvial deposits (less that 10 feet thick) and surficial soils formed on highly weathered crystalline rock. Debris chutes and drainage channels may be locally backfilled with colluvium of moderate thickness, but in general, the upper slopes are not likely to be underlain by thick, laterally continuous deposits of colluvium. Lower slope areas are expected to be underlain by much deeper and laterally extensive colluvial deposits consisting of a matrix of silty sand and clay around larger cobbles and boulders.

Bedrock

Larsen (1948) used the term Bonsall Tonalite to describe the rocks underlying the western ridge of Gregory Canyon, and the term Indian Mountain Leucogranodiorite to describe the light-colored, bold outcrops of granitic rock underlying the eastern ridge. Larsen also mapped an intervening band of metamorphic rock along the lower slopes of the eastern ridge, which he correlated with the sedimentary Triassic/Jurassic Bedford Canyon Formation. Rocks of this unit have relict volcanic textures, however, and are probably best correlated with the Jurassic Santiago Peak volcanics. A description of each of these bedrock materials is presented below. Additional discussion of the metamorphic rocks and the nature of its contacts with the leucogranodiorite and tonalite is provided in Appendix C.

Metamorphic rocks (TJm). Of the 183 acres of the landfill footprint, approximately 12 acres along the eastern side encroach over the outcrop of metamorphic rocks. The metamorphic rocks present along the easterly slopes of Gregory Canyon form a north-south-trending belt of older rock that was intruded (i.e., the action of forcing magma between pre-existing rocks) by magma that formed intrusive rocks (Figure 29). Specifically, the magma that crystallized into the tonalite intruded and intermingled with the metamorphic rock, and both of these units were subsequently intruded by the magma that crystallized into the leucogranodiorite .

The metamorphic rock includes amphibolites and metavolcanic rocks that locally exhibit some migmatitic structure (i.e., alternating dark and light banding in response to partial melting of the rock as it comes in contact with magma). The rocks are generally dark bluish gray, hard, and only slightly weathered with aphanitic to porphyroblastic textures. Relict porphyritic textures suggest a volcanic parent rock for some of the units.

Larsen (1948) correlated these metamorphic rocks with the Bedford Canyon Formation (a sequence of mildly metamorphosed sedimentary rocks represented by deformed slates, schists, quartzites and localized occurrences of marble), which is widespread in the Santa Ana Mountains. At Gregory Canyon, however, there are no outcrops of slates, quartzites or marbles, and there is a preponderance of metavolcanic rocks. It seems more reasonable to correlate the Gregory Canyon sequence with the Jurassic Santiago Peak volcanics, a unit composed of metavolcanic and metasedimentary rocks exposed elsewhere in San Diego County.

Tonalite (Kbt). The tonalite that underlies the western slope and the central portion of Gregory Canyon is an extensive rock unit in the area of the proposed project and Larsen (1948) referred to it as the Bonsall Tonalite. The tonalite is a dark gray, phaneritic rock, with medium- to coarse-crystallinity that varies in composition from tonalite to gabbro. Other common variations noted in the tonalite are the locally veined and streaked appearance and the migmatitic fabric that is observed near the contact with the metamorphic rocks. The rock is also characterized by rare inclusions of the metamorphic rocks, and by numerous leucogranodiorite dikes that include fine-grained aplites and coarse-grained pegmatites. The tonalite comes in contact with the metamorphic rock along the easterly side slopes of Gregory Canyon, although the contact is typically covered by colluvium or obscured by surficial soils. Because the metamorphic rocks were intruded by the tonalite at a relatively high temperature (900° to 1200° C), where the contact was observed in our field investigations, it is irregular and somewhat transitional due to the effects of partial melting of the pre-existing metamorphic rock Based on its map position, as inferred from isolated outcrops of both rock types, the contact appears to dip to the east at angles of 20 to 25 degrees.

The tonalite is moderately to intensely weathered in most outcrops, although small cores of only slightly weathered tonalite do form boulder knobs on the western flank of Gregory Canyon. Moderately weathered tonalite still preserves its phaneritic texture, but is less cohesive than the pristine rock, with the constituent minerals slightly altered to oxides and clays, particularly along the edges. The intensely weathered tonalite is oxidized throughout and has a granular texture that only vaguely reflects the original phaneritic texture. The constituent minerals are partially altered to oxides and clays, and disaggregate easily under pressure. The depth of weathering, as determined in exploratory drilling by Geraghty & Miller (1990), ranges between 65 feet (GMP-3) and 95 feet (GMW-2).

Geraghty and Miller (1990) reported the results of two seismic refraction traverses across the tonalite, and concluded that at depths shallower than 30 feet the seismic wave velocity in weathered tonalite was approximately 3,000 feet per second (ft/sec). At depths greater than 30 feet, seismic wave velocity increased to between 11,000 and 17,000 ft/sec. In general, excavation of materials with seismic velocities greater than 7,000 to 11,000 ft/sec requires blasting.

Leucogranodiorite (Kglg). The leucogranodiorite map unit is a light-colored, biotite-bearing granodiorite that forms the prominent mountain flanking the eastern side of Gregory Canyon (Figure 29). Although this prominent mountain is referred to as Gregory Mountain, Larsen (1948) referred to it as Indian Mountain and to the granodiorite as the Indian Mountain Leucogranodiorite. In hand specimen, the rock has medium- to coarse-crystallinity, is light gray to buff, and has less than five percent dark minerals (biotite and iron-titanium oxides).

Besides forming the core of Gregory Mountain, the leucogranodiorite also forms dikes that cut older units and vary in thickness from less than an inch up to five feet.

The degree of weathering of the leucogranodiorite is generally slight, as can be inferred from the bold outcrops of Gregory Mountain. Though the hardness and coherence of these rocks generally makes them unrippable, no grading is planned in the outcrop area of this unit. In contrast, leucogranodiorite dikes vary in degree of weathering from low to moderate, and should offer no significant resistance to ripping. Moderately weathered dikes are pervasively oxidized and have "cloudy" feldspars, but still preserve their phaneritic texture.

The main body of the leucogranodiorite is in intrusive contact with the metamorphic screen midway along the easterly slope of Gregory Canyon. The contact zone is generally buried under talus, but is narrow and abrupt where it can be observed. Based on its map position, as inferred from the abrupt change in topography, the contact is nearly vertical.

D.4.2.1 DISCONTINUITIES IN OUTCROP

Structural discontinuities (joints, dikes) are common in the rocks that form the substrate of the canyon. Based on an extensive study of structural discontinuities in both outcrop and exploration boreholes, GLA (1998) concluded that the main orientations of discontinuity were:

	Dip direction	Dip angle
Direction 1	270º	65º
Direction 2	90º	80º
Direction 3	255º	60º
Direction 4	330º	65º
Direction 5	360º	45º

If the structural attitudes of fractures and dikes are plotted separately, the stereonet plot for the fractures has primary maxima that correspond to Directions 1 and 2 in the table above, whereas the plot for dikes has maxima that correspond to Directions 3 and 4. Direction 5 may represent the compression counterpart of north oriented (Direction 1) tension fractures. These predominant orientations are consistent with the overall tectonic stress regime of the area, as described in Section D.4.1.

D.4.2.2 DISCONTINUITIES IN BOREHOLES

Fourteen boreholes were logged with an optical borehole imaging probe (BIP), which provides the highest resolution available for fracture and feature analysis in boreholes. This technique is based on direct optical observation of the wall of the borehole and is recorded on videotape for viewing. Based on inspection of the BIP log each fracture is identified with a depth, orientation, and fracture ranking from 0 to 5, with a 0 indicating a closed feature, and 5 indicating a wide aperture fracture or fracture zone. Most of the fractures rank from 0 to 2, with 20 cracks ranked at 3, only two fractures ranked at 4 (GLA, 1997), and none at 5. Structural orientation and spatial distribution patterns of fractures in boreholes were consistent with the analysis of similar outcrop data (Section D.4.2.1).

D.4.3 ENGINEERING AND CHEMICAL PROPERTIES OF GEOLOGIC MATERIALS

A discussion of the geologic materials on the site is provided in Section D.4.2. Laboratory testing was completed by Woodward-Clyde Consultants (WCC; 1995) on soil samples obtained from test pits excavated at the site (Figure 29), to assess the engineering characteristics of the site materials proposed for use in landfill operations. Compaction tests were performed on material finer than the Number 4 sieve. A summary of these test results is presented in Table 10. Strength and compression tests were performed on samples remolded to approximately 90% of their maximum dry density. A summary of these strength test results is presented in Table 11. The results of the consolidation tests are presented in Table 12, and laboratory permeability tests were also performed and are presented in Table 12a. In addition, GLA performed an investigation of the site stratigraphy and nature of the metamorphic rocks on the east side of the site, and a petrographic analysis of the bedrock including rock descriptions and mineralogy. The results of this investigation are summarized in Section 1.2.2 (Bedrock) of the Geologic, Hydrogeologic and Geotechnical Analysis Report (GLA, 2003), in the JTD Appendix C. A discussion of the mineral resources at

TABLE 10
GREGORY CANYON LANDFILL
SUMMARY OF LABORATORY COMPACTION TEST RESULTS

SAMPLE NUMBER	SOIL DESCRIPTION	MAXIMUM DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)
TP2-4	Clayey fine sand (SC)	129.5	10.5
TP3-1	Fine sandy lean clay (CL)	128.0	10.5
TP4-4	Fine sandy lean clay (CL)	131.0	10.0
TP4-5	Silty sand (SM)	131.0	8.5
TP5-3	Silty fine sand (SM)	121.0	12.5
TP8-1	Silty fine sand (SM)	129.5	8.5
TP9-1	Silty fine sand (SM)	132.0	9.5
TP9-2	Silty fine sand (SM)	127.0	10.0
TP10-1	Silty fine sand (SM)	133.5	8.5
TP10-2	Silty fine sand (SM)	133.0	9.0

Source: Final Environmental Impact Report, 2000 (Woodward-Clyde, 1995).

TABLE 11
GREGORY CANYON LANDFILL
SUMMARY OF STRENGTH TEST RESULTS

SAMPLE NUMBER	SAMPLE DEPTH (ft)	SOIL CLASSIFICATION	GEOLOGIC UNIT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	NORMAL STRESS	COHESION (psf)	FRICTION ANGLE (degrees)
TP2-4	3-5	Clayey fine sand (SC)	Highly Weathered Granite	11	116	Low	440	28
TP3-1	1-2	Fine sandy lean clay (CL)	Residual Soil	11	114	Low	240	28
TP4-5	4-7	Silty sand (SM)	Highly Weathered Tonalite	9	119	Low	500	47
TP5-3	3-5	Silty fine sand (SM)	Highly Weathered Tonalite	13	108	Low	720	32
TP5-3	3-5	Silty fine sand (SM)	Highly Weathered Tonalite	13	109	High	1,500	30
TP8-1	1-2	Silty fine sand (SM)	Colluvium	9	117	Low	650	39
TP9-1	1-3	Silty fine sand (SM)	Colluvium	10	121	Low	770	30
TP9-2	3-6	Silty fine sand (SM)	Highly Weathered Granite	10	114	Low	660	41
TP10-1	1-4	Silty fine sand (SM)	Colluvium	9	120	Low	680	33
TP10-1	1-4	Silty fine sand (SM)	Colluvium	9	120	High	1,120	33
TP10-2	4-7	Silty fine sand (SM)	Older Colluvium	9	120	Low	610	33
TP10-2	4-7	Silty fine sand (SM)	Older Colluvium	9	120	High	150	35

Source: Final Environmental Impact Report, 2000 (Woodward-Clyde, 1995).

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TABLE 12
GREGORY CANYON LANDFILL
SUMMARY OF CONSOLIDATION TESTS

SAMPLE NUMBER	DEPTH (ft)	SOIL DESCRIPTION	LIQUID LIMIT	PLASTICITY LIMIT	VIRGIN COMPRESSION INDEX
TP2-4	3 to 5	Clayey Sand (SC)	29	14	12.4
TP4-4	1 to 5	Fine Sandy lean clay (CL)	23	13	16.8
TP9-1	1 to 3	Silty Sand (SM)	—	NP	11.3

Source: Final Environmental Impact Report, 2000 (Woodward-Clyde, 1995).

NP = Non-plastic

All samples inundated with water at 2 ksf.

TABLE 12A
GREGORY CANYON LANDFILL
SUMMARY OF LABORATORY PERMEABILITY TEST RESULTS

SAMPLE NUMBER	SOIL DESCRIPTION	DRY DENSITY (pcf)	NO. 200 SIEVE (%)	HYDRAULIC CONDUCTIVITY* (CM/SEC)
TP2-4	Clayey fine sand (SC)	116	44	3.7×10^{-6}
TP3-1	Fine sandy lean clay (CL)	115	56	3.8×10^{-7}
TP4-4	Fine sandy lean clay (CL)	118	58	7.3×10^{-7}
TP4-5	Silty sand (SM)	118	18	3.5×10^{-4}
TP5-3	Silty fine sand (SM)	109	42	1.1×10^{-6}
TP8-1	Silty fine sand (SM)	116	26	7.4×10^{-7}
TP9-1	Silty fine sand (SM)	119	43	7.3×10^{-7}
TP9-2	Silty fine sand (SM)	114	21	1.6×10^{-4}
TP10-1	Silty fine sand (SM)	120	34	7.8×10^{-6}
TP10-2	Silty fine sand (SM)	120	32	7.6×10^{-6}

* Samples remolded to 90% relative compaction (maximum density per ASTM D-1557) at optimum moisture content.

Source: Final Environmental Impact Report, 2000 (Woodward-Clyde, 1995).

the site and in the surrounding area is included in Section 1.2.4 of the GLA (2003) report (Appendix C).

D.4.4 FAULTING

The site is located within a tectonically active region. Several active faults exist within 60 miles of the property. These include the San Andreas, San Jacinto, Elsinore, and Rose Canyon/Newport-Inglewood fault zones. No known active or potentially active faults have been located on the property. The nearest active faults in the area are the Elsinore Fault, located approximately 6 miles northeast of the site, and the Rose Canyon Fault located about 23 miles southwest of the site. All of these faults are the result of the right-lateral strike-slip motion between the North American and Pacific plates, although the individual fault strands within the Elsinore fault zone may have strike-slip, normal, or thrust fault motions as a result of complex local geometries (Lamar and Rockwell, 1986). The northwest-trending fabric of the fault zone also results in distinctive structural features, including large-scale structural depressions like the Elsinore Trough, and structural highs such as the Agua Tibia Mountains.

Of more immediate interest to the structural setting of Gregory Canyon is the fact that the "block" between the Elsinore fault zone to the northeast and the Rose Canyon fault zone to the southwest is under a shear stress regime (Figure 30). In effect, the area between both fault zones is being "wrenched" clockwise by the relative motion along these faults. Under these conditions, north-oriented extensional fractures would form as shown in the stress diagram of Figure 30. This is the most likely explanation for the predominance of north-striking fractures on the site, and for the dominant orientation of topographic lineaments in the region.

<u>Local Setting</u>. Faulting was evaluated by WCC (1995) for the project and surrounding area based on a review of geologic literature, large- and small-scale stereo aerial photographs, and field reconnaissance data. GLA (1997) augmented the lineament analysis by inspecting historical aerial photographs of the area to identify potential structural discontinuities at or near the GCLF, and concluded that there were no regional, through-going discontinuities across the footprint of the site. Likewise, geologic mapping of the site did not disclose the existence of major faults across the footprint of the landfill, although thin shear

zones of limited lateral extent were mapped. Some of these shear zones have been annealed by granitic dikes, which demonstrates that they are Mesozoic in age.

The closest mapped faults to the site are an east-northeast-trending fault first located by Jahns and Wright (1951), and a shear zone described by WCC (1995) (Appendix N, Figure 3). The Jahns and Wright (1951) fault is the only nearby fault depicted in the 1994 Fault Activity Map of California (Jennings, 1994), and it shows no evidence for Cenozoic displacement.

With respect to the potential shear zone located across Highway 76, WCC (1995) noted that there is no evidence to support continuity of the high-angle shear feature (such as lineations or similar exposures) along its general strike to the north or south. From this, they inferred it to be a localized feature. GLA (1999) inspected this outcrop, and concluded that the so-called shear zone was a steep planar contact between metamorphic rocks and hydrothermally-altered gabbro. The gabbro is brecciated (i.e., the rock is not homogeneous, but rather it is formed by an agglomeration of angular blocks), but the fragments do not show tectonic shearing, alignment, or fault gouge between them. A couple of hundred feet east of the contact the rock becomes progressively less brecciated and hydrothermally altered.

The 200-foot zone of brecciated gabbro does not have the characteristic features of a fault zone since such a thick "fault zone" would be indicative of a major fault, and shearing should be pervasive. In fact, there are no prominent shear planes through this portion of the outcrop. In addition, careful inspection of the ravines to the north of the outcrop did not disclose continuation of the breccia, so GLA concludes that it has the shape of a vertical chimney, rather than a planar feature. The limited extent of the breccia zone in the strike direction is uncharacteristic of a major fault zone, as such structures normally extend for several miles. In contrast, intrusive breccia chimneys or pipes are a common feature in shallow plutons (e.g., Norton and Cathles, 1974), and characteristically show the effects of hydrothermal alteration.

To confirm this interpretation, GLA made a careful inspection of the north flank of Gregory Mountain, where the contact would be reasonably expected to project if it were an extensive planar feature. This inspection identified only non-brecciated tonalite/gabbro along the northern flank of Gregory Mountain, thus confirming that the gabbroic breccia does not extend across the San Luis Rey River. The GLA (2003) report provides a discussion of this study and includes photographs of the various contacts in Attachment 2 of Appendix C.

D.4.5 SEISMICITY

The Elsinore fault zone, located approximately six miles from the site, is the most likely source of strong seismic motion in the area of the Gregory Canyon landfill site. The Elsinore fault extends 150 miles from the Mexican border to the northern edge of the Santa Ana Mountains. Five earthquakes of magnitude greater than 5 have been generated along this fault during the last 100 years, three of which had epicenters near Lake Elsinore.

For the GCLF, to apply an additional margin of safety, the site was designed for the Maximum Credible Earthquake (MCE). An MCE event of M7.1 was used for the Elsinore-Julian Fault and M6.8 was used for the Elsinore-Temecula Fault (CDMG, 1996). For this analysis, a deterministic estimation of the peak horizontal acceleration was calculated for the MCE using the computer program EQFAULT (Blake, 2000), which calculates the MCE for all faults in the database within 100 miles of the site using different attenuation relationships. A series of attenuation relationships, based on published seismological papers, were used to produce the range of peak horizontal accelerations presented below.

Maximum Credible Earthquake

Fault Scenario	Range	Mean/Average
Elsinore-Temecula fault M6.8 earthquake 5.5 miles (8.8 km) from the site	0.2g to 0.39g	0.34g
Elsinore-Julian fault M7.1 earthquake 6.0 miles (9.6 km) from the site	0.22g to 0.40g	0.35g
San Andreas fault-Southern Segment M7.4 earthquake 47.7 miles (76.7 km) from the site	0.04g to 0.07g	0.06g
San Jacinto-Anza fault M7.2 earthquake 28.1miles (45.3 km) from the site	0.08g to 0.11g	0.09g
Newport- Inglewood/Rose Canyon fault M6.9 earthquake 22.6 (36.4 km) from the site	0.08g to 0.12g	0.09g

From these estimates, assuming a MCE event, the area of the Gregory Canyon landfill site expansion is likely to experience short-period peak horizontal accelerations between 0.2g and 0.4g for a near-field earthquake and about 0.1g for a far-field earthquake.

D.4.6 STABILITY ANALYSES

As detailed in Appendix C, slope stability analyses were completed taking into account the site's tectonic setting and seismic exposure potential, using the proposed site development plan, available soils characteristics and published geosynthetic material strengths.

The static factor of safety is defined as the ratio of the forces resisting failure to the forces driving failure. Static conditions are those in which no external forces are imposed on the refuse prism. Although the static stability of landfill cut slopes is not regulated per se, the standard of practice has converged on identifying static factors of safety of at least 1.5 for cut slopes that will be unsupported for more than a few years.

Kinematic analyses that were completed to evaluate the cut slopes for the landfill design indicate that large scale, block-slip movement and wedge failure are not likely given the geometry of the dominant directions of discontinuities in Gregory Canyon identified by the geologic investigations. In addition, because the rocks exposed in Gregory Canyon are compact and cohesive, even when weathered, circular failure of the cut slopes is unlikely.

GLA also reviewed the stability of the cut slopes and stockpile slopes in the borrow/stockpile areas. Based on the kenematic considerations and structural features of the rocks exposed at Gregory Canyon, it was concluded that block failures, wedge failures and circular failures of 2:1 (H:V) cut slopes are not likely. For the stockpiles, as provided in GLA's (2003) report (Section 3.3.2 of Appendix C), the computer program SLOPE/W was used to analyze the static stability for two cross-sections through the stockpile slopes. Based on the nature of the materials anticipated to be placed in the stockpiles, a unit weight of 120 pcf, a friction angle of 32° and cohesion of 250 psf were considered reasonable and were used in the slope stability analysis. Results of the analysis indicated a calculated minimum static factor of safety of 1.9. The borrow area cut slopes excavations will be developed to a maximum gradient of 2:1 (H:V). Therefore, potential impacts related to borrow/stockpile area design and slope stability concerns are considered less than significant.

GLA recently performed slope stability analyses for the prescriptive standard design and this analysis is summarized in the GLA (2003) report provided in Appendix C (Section 3.3.3) of the JTD. The stability analyses look at the strength parameters of the composite liner system. Section C.2.4 presents a description of the liner design. The interface strengths for each of these liner components can be used to evaluate the stability of the refuse prism and underlying liner system using standard slope stability calculation methods.

In performing the slope stability calculations, only the weakest or most critical elements of the liner system have been used. Specifically, for the analyses, the critical elements are the refuse prism and the interface between the non-woven geotextile and the HDPE membrane. The parameters used in the analyses are as follows:

Material	Unit Weight	Friction Angle	Cohesion
Refuse Fill	80 pcf	30°	200 psf
Smooth HDPE/Geotextile	NA	8°	0 psf
Textured HDPE/Geotextile	NA	14°	0 psf

Cross section A-A' was generated to show the final grade profile of GCLF in the center of the canyon with the landfill configuration and incorporates the most critical section with regard to slope stability for the site (see Figure 3-4 of Appendix C). The slope stability analyses were performed using the computer program SLOPEW (Geo-Slope, 1995). Analytical methods available in the program include Bishop method for circular failure modes, and Spencer and Morgenstern and Price methods for general failure modes including block and non-circular failure surfaces. The static factor of safety for the critical failure plane for section A-A' is calculated to be greater than 1.50, which meets the 27 CCR standard.

The pseudo-static analyses for section A-A' indicates a factor of safety of 0.85, with a seismic coefficient of 0.15. The yield acceleration (the seismic coefficient that results in a factor of safety of 1.0) for section A-A' is calculated to be 0.10g.

27 CCR, Section 21750 (f)(5)(C) states that the critical slope of the final refuse prism must have a factor of safety of at least 1.5 under dynamic conditions, and that if this is not the case a more rigorous analysis must be performed to estimate the magnitude of movement under seismic loading conditions. Since the results of pseudo-static (dynamic) analyses failed to yield a factor of safety greater than 1.5, displacement analyses were completed to evaluate the amount of displacement that could occur within the landfill and containment system under seismic loads associated with a M 7.1 earthquake on the nearby Elsinore fault.

Dynamic stability analysis was performed for the MCE site acceleration of 0.4g using the methods of Bray and Rathje (1998). This method calculates the seismically induced permanent displacement for the fill slope due to the postulated MCE and is regarded to be more representative of actual conditions within a landfill than the TNMN computer software, which analyzes for a simple sliding block (Pyke, 1992). The procedure of Bray and Rathje (1998) involves estimating the maximum horizontal equivalent acceleration (MHEA) for the potential sliding wedge based on the slope geometry, material properties, and characteristics of the MCE. For the prescriptive standard design, the following parameters were used:

- Slope Height - 300 feet
- Average Shear Wave Velocity of Refuse Fill - 1,200 feet/second (Bray and Rathje, 1998)
- MCE Site Acceleration - 0.40g
- Mean Period of Shaking - 0.50 seconds (Bray and Rathje, 1998)
- Significant Duration of MCE - -16 seconds (Bray and Rathje, 1998)

Based on the analysis method of Bray and Rathje (1998), the displacements calculated to occur to the total refuse prism and liner is about 0.1 inches for the prescriptive configuration. This is less than the commonly acceptable range of 6 inches to 12 inches (Seed and Bonaparte, 1992). The calculations used to determine the seismic-induced permanent displacement for the GCLF along cross-section A-A′ are provided in Attachment 5 of the GLA (2003) report, included as Appendix C.

In addition, it is believed that the worst case conditions incorporated into these dynamic stability analyses also take into account strong motion from aftershocks as required by 27 CCR, Section 21750(f)(7).

Finally, slope stability calculations were performed for the final cover system for closure of the GCLF. The final cover design assumes a prescriptive low-permeability final cover in accordance with 27 CCR, Section 21090. It consists of a two-foot foundation soil layer, a synthetic barrier layer, and a two-foot thick vegetative soil layer. The vegetative soil layer was assumed to consist of on-site soils that are silty sand to sandy silt and compacted to a minimum relative compaction of 90 percent. The barrier layer will consist of a 60-mil thick Linear Low-Density Polyethylene (LLDPE) geomembrane (for deck areas only), textured on both sides. The foundation layer was assumed to consist of compacted random soil. The proposed final grading plan will have an overall slope gradient of 4:1 (horizontal: vertical) including roads and benches at approximately 40-foot vertical intervals and a gradient between benches of 3:1 (horizontal: vertical).

For the slope stability analysis, the interface between the LLDPE geomembrane and the overlying vegetative soil cover was considered the critical surface. The following parameters were considered appropriate and used in the analysis:

Thickness of vegetative soil layer	2 feet
Total density of soil in the vegetative layer	100 pcf
Angle of internal friction at the interface between soil and LLDP geomembrane	27 degrees
Maximum ground acceleration for the postulated MCE at the site	0.40g

The slope stability analysis was conducted considering the final cover as a semi-infinite slope with a gradient of 3:1 (H:V). For the design parameters listed above, the analysis indicated a static factor of safety of 1.53 if the tensile strength of the geomembrane is ignored, and 1.69 when considering the tensile strength of the LLDPE.

The seismic induced permanent displacement due to the postulated seismic exposure of the site was then calculated using the procedure described by Makdisi and Seed (1978). The procedure first requires calculation of yield acceleration (k_y), the acceleration value for which a pseudo-static analysis yields a factor of safety of 1.0. K_y was evaluated and found to be equal to 0.185g. The ratio k_y/k_{max}, where k_{max} is the maximum ground acceleration at the site (0.40g), was then calculated. The value of the estimated permanent displacement was then read from a chart developed by Makdisi and Seed normalized for the period of the waste and related to the magnitude of the earthquake event. Using this procedure, the calculated seismic-induced permanent displacement for the final cover during the postulated maximum credible earthquake at the landfill ranges from 1.7 to 5.1 inches depending on the thickness of the waste prism. Using the methods of Bray and Rathje (1998), the estimated seismic displacement under the loading of the MCE ranges from 0.5 to 3.7 inches, depending on the waste thickness. These estimated displacements are less than the commonly acceptable range of seismic displacement of 6 inches to 12 inches (Seed and Bonaparte, 1992) and would not be expected to inhibit the functional integrity of the cover. In addition, damage to the cover should be evident in post-earthquake inspection and can be easily and quickly repaired as a part of post-earthquake maintenance. The seismic-induced permanent displacement calculations for the prescriptive final cover are provided in Attachment 5 of the GLA (2003) report, included in Appendix C.

D.4.7 GEOLOGIC HAZARDS DUE TO SURFACE AND NEAR SURFACE PROCESSES

Landslides

The potential for landsliding was evaluated by WCC (1995) based on review of stereo aerial photographs and field reconnaissance study and geologic or geomorphic features characteristic of landslides were not observed in or adjacent to the landfill site. However, the natural slopes will be modified by the project and the stability of these man-made cut slopes are of potential concern.

The three most common types of cut-slope failures are block-slip failures, wedge-slip failures, and circular failures. Block-slip failures are most common in slopes that are underlain by bedrock with distinctive partings (e.g., fractures) that dip in the same direction but at a shallower angle than the cut. Wedge-slip failures occur when the bedrock has two or more partings (e.g., a weathered dike and a joint) with orientations such that their line of intersection dips at a shallow angle in the direction of the cut. Finally, circular failures develop where the substrate is loosely consolidated and comparatively homogeneous.

As stated in Section D.4.6, a stability assessment was performed using a kinematic analysis (Norrish and Wyllie, 1996), to see if movement along one or more of the main discontinuity planes is possible. The kinematic analysis shows that large-scale block-slip movement and wedge-failure are not likely given the geometry of the dominant directions of discontinuity in Gregory Canyon. However, mapping should be performed and this conclusion reevaluated as the excavation proceeds. It is also possible that small-scale, localized block falls may occur when fractures daylight the cut or where a higher density of fractures are encountered during excavation.

As previously indicated, circular failures develop where the substrate is loosely consolidated and comparatively homogeneous. All the rocks exposed at Gregory Canyon are compact and cohesive, even when weathered, so a circular failure of the cut slopes is similarly unlikely. As a result, the proposed cut slopes are anticipated to be stable and no significant impacts are anticipated.

Rockfalls

Rockfalls are abrupt movements of independent blocks of rock that become detached from steep slopes. Falling rocks can reach the base of a slope by free-falling, bouncing, rolling down the slope surface, or by some combination of the above. There is clear evidence that rockfalls have occurred at the site during mass wasting of Gregory Mountain located east of the proposed project.

A first scenario was calculated by GLA (1998) for elastic bouncing trajectories, which yield the maximum encroachment of a bouncing rock fragment into the footprint of the landfill. The encroachment distance from the edge of refuse was estimated at 300 feet, and the travel time from the top of the profile to its final resting point was estimated at 22 seconds. GLA (1998) calculated a second scenario, incorporating the more realistic condition that some of the kinetic energy of the falling rock fragment would be dampened by impact. The bouncing rock would stop within a few feet after reaching the limit of refuse with an estimated travel time of 23 seconds. The analysis of this scenario indicated that the bouncing trajectories become smaller in length and traveling height as the bouncing rock fragment moves from the medial to the lower reaches of the slope. A third scenario addressed rolling particles, and suggested that rolling rock fragments could travel as much as 360 feet onto the landfill if unchecked.

Based on this analysis, construction of a "catching" wall or other diversion structure near the edge of the landfill is recommended to effectively mitigate the risk of rock fragments rolling onto the landfill. Rockfall trajectories can reasonably be expected to be even shallower and shorter for profiles with gentler slopes. The conclusions reached through the analysis of this profile are of general application throughout the eastern slope of the landfill site.

Debris flows

Earth, mud, and debris flows form when a mass of unconsolidated sediment is mobilized by sudden ground vibration (e.g., an earthquake) or by a sudden increase in weight and pore water pressure (e.g., after soaking of the soil by heavy rains). The initial movement of a flow is enhanced by steep topography and deforestation, but once mobilized flows can spread over gently sloping terrain.

Debris flows cannot be forecasted, but the susceptibility for formation of debris flows on any given site can be estimated by looking for evidence of previous flow events. GLA (1998) reviewed aerial photographs of the site, and concluded that there is a deposit of poorly-sorted colluvium that could have been formed as a debris flow deposit (Qd(?) on Figure 29). The deposit forms a landform with a rough lobate shape and comparatively steep boundaries, but lacks levees or pressure ridges, and so could also have been formed by erosion of an older colluvial fan.

The natural development of vegetation will reduce potential debris flow hazards. Special precautions such as diversion structures near the upper reaches would need to be taken if vegetation is destroyed. The diversion structures should be built so as to be permeable, allowing almost free draining of runoff, but should capture high viscosity earth-, mud- or debris.

SECTION D.5

WATER RESOURCES

D.5 WATER RESOURCES

D.5.1 HYDROGEOLOGY

D.5.1.1 REGIONAL HYDROGEOLOGIC SETTING

The GCLF is located within the San Diego Hydrologic Basin, which occupies approximately 3,900 square miles of San Diego County and portions of Orange and Riverside Counties in southwestern California. The hydrologic basin lies within the Peninsular Ranges physiographic province of California. The physiographic province is characterized by a relatively narrow coastal plain on the west, and rugged mountains and steep-walled, narrow valleys inland that generally trend from east to west.

The Gregory Canyon watershed is tributary to the San Luis Rey River and is part of the San Luis Rey Hydrologic Unit. The San Luis Rey River occupies a narrow valley filled with water-bearing alluvial sediments bounded by sedimentary rocks (lower reach of the basin), or igneous and metamorphic rocks (middle and upper reaches of the basin) at the valley margins. The San Luis Rey Hydrologic Unit is divided into three hydrologic areas from east to west, which include the Warner, Monserate and Lower San Luis (Mission). The GCLF is to be constructed in the Monserate Hydrologic Area, which occupies approximately the middle one-third of the San Luis Rey Hydrologic Unit and is further subdivided into three hydrologic subareas which include, from east to west, the La Jolla Amago, Pauma and Pala Hydrologic Subareas. The GCLF is located in the Pala Hydrologic Subarea of the Monserate Hydrologic Area (RWQCB, 1994).

Recharge to the Monserate Hydrologic Area occurs by infiltration of precipitation, subsurface flow from the Warner Hydrologic Area, and infiltration of run-off from the surrounding mountain areas. Surface water flow in the San Luis Rey River is impounded by the dam at Lake Henshaw in the Warner Hydrologic Area, approximately 23 miles upstream of the GCLF.

The alluvial deposits along the San Luis Rey River form narrow elongated groundwater basins. Groundwater moves downgradient through these basins, from east to west, from the Pauma Basin to the Pala Basin to the Bonsall Basin. For these aquifers, the boundaries of each aquifer are drawn where the basement complex (hard crystalline rock) is exposed at the surface and distinct bedrock constrictions in the San Luis Rey valley separate the valley fill into these three separately defined basins (e.g., the Monserate Narrows just west of Rice Canyon Road and Highway 76 separates the Pala and Bonsall Basins). Since groundwater recharge is inconsistent and seasonal, historical depth-to-water measurements from the period 1965 to 1990 for the alluvial aquifer (Pala Basin) indicate that groundwater levels for a particular well may fluctuate from the ground surface to approximately 25 feet below ground surface (bgs) in the center of the river valley (California Department of Water Resources [CDWR], 1971; U.S. Geological Survey [USGS], 1990). Colluvial deposits, consisting of sediments ranging in size from clay to boulders interfinger with the alluvial sands and gravels along the margins of the river valley, and underlie the tributary canyons as well. The alluvial deposits of the San Luis Rey River, which are composed of clay- to gravel-size material, and the colluvium occupying the valley margins and tributary canyons overlie variably weathered bedrock. Although the Pala Basin crosses the Gregory Canyon site, the GCLF footprint is located to the south of and outside of the Pala Basin (Figure 10C). Table 12B provides a summary of the aquifer characteristics of the basins both up- and downgradient of the project site as obtained from studies prepared by SDCWA (1997) and NBS Lowry (1995) for SDCWA. The project site is tributary to the Pala Basin and is located in the lower reach of the Pala Basin (about 1.6 miles east of Monserate Narrows and the upper reach of Bonsall Basin). As described in Table 12B, the Pala Basin covers approximately 4,500 acres, being nearly eight miles long and averages about 0.5 miles in width (NBS Lowry, 1995).

Total thickness of the alluvial sediments in the Pala Basin ranges from zero at the basin margins to in excess of 165 feet, over the GCLF bridge crossing (GLA, 2000). A study by the USGS (Moreland, 1974) estimated the maximum depth of the alluvium in the Pala Basin at 244 feet (in one well 9S/2W-26G1 located in the far upper reach of the Pala Basin), and an average depth of 150 feet. At well GMW-2 located near the southern edge of the Pala Basin at the mouth of Gregory Canyon, the thickness of alluvium is only about 50 feet (G&M 1990).

Reported well yields for alluvium in the Pala Hydrologic Subarea range from 10 to 400 gallons per minute (gpm) (CDWR, 1971). As shown on Table 12B, a more recent study by NBS Lowry (1995) indicates that Pala Basin wells have a higher rate of production estimated to range from 300 to 1,600 gpm. Discrepancies in

TABLE 12B
GREGORY CANYON LANDFILL
SUMMARY OF AQUIFER CHARACTERISTICS IN THE VICINITY OF THE PROJECT SITE

PARAMETER	BONSALL BASIN[1]	PALA BASIN[2]	PALA/PAUMA BASINS[1]
Aquifer Type	Alluvial/Unconfined[2]	Alluvial/Unconfined[3]	Alluvial/Unconfined[3]
Primary Source of Recharge	Streamflow infiltration from San Luis Rey River[7]	Streamflow infiltration from San Luis Rey River[3]	Streamflow infiltration from San Luis Rey River[3]
Aquifer Composition	Medium to coarse grained sand and gravel[7]	Medium to coarse grained sand and gravel[3, 5]	Medium to coarse grained sand and gravel[3]
Areal Extent of Alluvial Aquifer	5000 acres[7]	4500 acres[2]	8800 acres[4]
Maximum Depth of Alluvium	130 feet[7]	244 feet[3]	240 feet (downstream half); 130 feet (upstream half)[3]
Average Depth of Alluvium	80 feet[7]	150 feet[3]	120 feet[2, 6]
Estimated Storage Capacity	25,000 acre-feet[7]	50,000 acre-feet[5]	120,000 acre-feet[3]
Estimated Mean Storage Coefficient	10 to 12 percent[3]	12 percent[3]	10 to 12 percent[2, 6]
Estimated Mean Hydraulic Conductivity	100 feet per day[6] (range of 60 - 250 feet per day)[3]	80 feet/day (estimated range of 15 - 150 feet/day)[3]	50 - 100 feet per day[3] (range of 15 - 150 feet per day)
Mean Hydraulic Gradient	0.005 feet/feet[7]	0.005 feet/feet[2]	0.005 feet/feet[2]
Average Well Production Capacity	750 gpm (prod. capacity ranges from 400 to 1100 gpm)[7]	1000 gpm (prod. capacity ranges from 300 to 1600 gpm)	750 gpm (prod. capacity ranges from 400 to 1100 gpm)[2]
Range of Total Dissolved Solids Concentrations	600 to 3400 mg/l[6]	200 to 860 mg/l[2]	200 to 900 mg/l[2]
Current Estimated Groundwater Pumping	2500 AFY[7]	2500 AFY[2]	8000 AFY[2]
Estimated Sustainable Yield Without Groundwater Mgmt.	5400 AFY[3]	2500 AFY[3]	8000 AFY[5]

Sources:
1. San Diego County Water Authority (1997). This source combines the Pala and Pauma Basin data.
2. NBS/Lowry (1995)
3. U.S. Geological Survey (Moreland, 1974)
4. Estimated from U.S.G.S. Topographic Maps
5. Woodward Clyde (1990)
6. NBS/Lowry and Stetson Engineers (1992)
7. NBS/Lowry (1994)

L:\gregory\97139\REPORTS\Oct 2003 JTD\TABLE-12B.xls: 5/30/03;Rev. 1: 10/21/2003 these production rates may be related to the fact that private domestic and agricultural wells are typically not metered to determine flow. As a result, for any particular study, well yields can only be grossly estimated. Specific capacities for alluvium along the axis of the subarea range from 13 to 115 gallons per minute per foot (gpm/ft) of drawdown (J.A. Moreland, 1974). Alluvium along the axis of the subarea may have hydraulic conductivities ranging from 750 to 1000 gpd/ft^2 (Moreland 1974). The SLRMWD, which controls the water activity in the lower third of the Pala Basin, has calculated the current average pumping rate in the Pala Basin to be 2,400 acre-feet per year (AFY) or approximately 7.8 million gallons per year (Owen, 1995). This result is similar to that calculated by the USGS (J.A. Moreland, 1974) of 2,500 AFY. In addition, the USGS (J.A. Moreland, 1974) has calculated a safe yield for the Pala alluvial basin to be 2,500 AFY. The best recharge areas are located in the central and west-central portions of this basin due to an abundance of coarse sand and gravel deposits and minimal clay material (NBS Lowry, 1995).

Beneath the alluvium/colluvium are granitic and basic crystalline rocks (bedrock). In bedrock, groundwater occurrence and movement depends upon the fracture size, the frequency density, and the interconnection between the fractures, rather than matrix properties as in alluvial soils. Though it is common usage to speak of a bedrock "aquifer" (as distinct from the alluvial aquifer), wells penetrating fractures containing groundwater are not typically a dependable source of water for large-scale agricultural, municipal or industrial uses and may be better defined as an aquiclude (a formation that will not transmit water fast enough to furnish an appreciable supply for a well or spring). Highly productive wells completed in fractured crystalline bedrock generally are located within alluvial valleys or basins, which store groundwater that is likely in hydraulic connection with underlying fractured bedrock. The groundwater contained within the overlying alluvium likely serves as a source of groundwater supply to the fractured bedrock (SDCWA, 1997). Based on visual reconnaissance of the project site and review of the USGS 7.5-minute topographic maps (Pala and Bonsall quadrangles), there are no springs within one mile of the project boundaries. For additional information, refer to the Geologic, Hydrogeologic, and Geotechnical Investigation report included in Appendix C, and the Supplemental Hydrogeologic Investigation Report (GLA, 2004) included in Appendix C-1.

D.5.1.2 LOCAL HYDROGEOLOGIC SETTING

Gregory Mountain is an elongated, relatively flat-topped prominence, drained to the east, north and west (into Gregory Canyon) by steep, rocky secondary canyons. The potential catchment area of the mountain is large and it clearly dominates recharge to Gregory Canyon. Recharge to Gregory Canyon from the west ridgeline and southern drainage divide, which are relatively minor topographic features by comparison, is believed to be relatively minimal. Though no permanent springs have been identified in Gregory Canyon, the vigorous development of riparian vegetation along the thalweg of the canyon, and its tributaries, suggests that the piezometric level of the underlying aquifer is close to the surface along the lowest points of the canyon. Studies by GLA and others, including the drilling and construction of groundwater monitoring wells, have assisted in evaluating groundwater flow within the project area.

There are two distinct groundwater zones within Gregory Canyon. An alluvial aquifer hosted by the sediment wedge at the mouth of the canyon, and a bedrock aquiclude, better defined as a fracture flow system, hosted by the fractured tonalite that forms the substrate of the canyon. Drilling and well installation data show that the overall direction of groundwater movement in both groundwater systems is to the north, toward the alluvial aquifer of the San Luis Rey River.

Alluvial Aquifer

An alluvial soil wedge occupies the lower reaches of Gregory Canyon. It pinches out to the south, before reaching the footprint of the landfill, and thickens to the north where it eventually merges with the channel deposits of the San Luis Rey River.

A 1995 study (WCC) concluded that groundwater within the alluvium forms an unconfined aquifer recharged by direct infiltration from precipitation or runoff from the bedrock ridges east and west of the canyon, and by underflow through weathered bedrock. Reported hydraulic conductivities for alluvium in the Pala basin range from 750 to 1,000 gpd/ft^2 (Moreland 1974). In contrast to the more coarse-grained sediment typical of the Pala Basin as a whole, WCC (1995) estimated that the hydraulic conductivity of alluvial and colluvial materials in the canyon ranges between 0.9 and 16 gpd/ft^2. The extent of the alluvial aquifer to the south is limited; however, as indicated by dry wells MW-4, WCC-1, WCC-2 and MW-5. The available data suggest groundwater flow is to the north, under a gradient of about 0.045 ft/ft.

Bedrock Fracture Flow System

There are 26 bedrock monitoring wells within the landfill footprint and along the periphery of the site. Studies conducted to date indicate that groundwater in Gregory Canyon can be characterized as a fracture-controlled, interconnected flow system. This fracture-controlled groundwater communicates with, and recharges the alluvial water in the San Luis Rey River valley (Pala Basin), although contributions from the bedrock are relatively minor relative to the volume of water transmitted through the alluvium.

Wells accessing the water-bearing fractures register water levels defining a systematic piezometric surface. A piezometric surface is slightly different than a water table, in that the bulk of the aquifer is dry and water is only present where an open continuous fracture lies below the piezometric level. The piezometric surface reflects the main elements of the topography and indicates a northerly groundwater flow dominated by Gregory Mountain as the principal recharge area of Gregory Canyon. Derivation of a piezometric surface from wells isolated from one another by non-water bearing rock attests to the hydraulic interconnection of the fracture system.

Subsequent to the Phase 5 hydrogeologic investigation, GLA conducted pumping tests in two wells (GLA-3 and GLA-8) to evaluate the hydraulic properties of the bedrock fracture flow system (GLA, 2001). Results of the pumping tests indicates that in the vicinity of well GLA-3, located at the toe of the landfill, the estimated average hydraulic conductivity is calculated to be about 3.7 ft/day (0.0013 cm/sec). In the vicinity of well GLA-8, located further up the canyon in unweathered tonalite, the estimated average hydraulic conductivity over longer-term conditions is 0.015 ft/day (5.3×10^{-6} cm/sec). A discussion of these two pumping tests is provided in Section 2.2.3 of GLA's (2003) report provided in Appendix C. A summary of the hydraulic conductivity and transmissivity data is also provided in Table 2-2 of Appendix C.

In order to provide an additional demonstration of the proposed groundwater monitoring system to effectively monitor the groundwater from the proposed landfill, GLA conducted a supplemental hydrogeologic investigation in the summer 2004, which included constructing seven bedrock wells to be used in the groundwater monitoring network at the downgradient limit of the landfill. A total of five long-term variable rate or constant rate aquifer pumping tests were performed along with three slug tests (drawdown-recovery) in bedrock wells as part of this supplemental hydrogeologic investigation (GLA, 2004). In addition, the hydraulic properties were calculated from the pumping test data. In these most recent pumping tests, the range of calculated hydraulic conductivity values ranged from 1.75 x 10^{-5} to 24.6 feet/day (6 x 10^{-9} to 8.6 x 10^{-3}, cm/sec) with hydraulic conductivity values highest (0.137 to 24.6 feet/day) in the "canyon" area wells. A discussion of the pumping tests and results is provided in the Supplemental Hydrogeologic Investigation Report (GLA, 2004) included in Appendix C-1.

Review of the sum of work performed to date by GLA and others (including well test results and all drilling logs), suggests that three fracture flow domains can be identified as follows:

- A groundwater flow barrier formed by the unweathered tonalite underlying the west ridgeline;
- A low flow zone forming an extension of the west ridgeline; and
- A maximum flow zone along the axis of Gregory Canyon in the weathered bedrock zone.

As presented in the Supplemental Hydrogeologic Investigation Report (GLA, 2004) (Appendix C-1), boring GLA-17, and wells GLA-4, GLA-9, and GMP-3, drilled along the west ridgeline to depths significantly below the projected equipotential surface are dry (one well, GLA 4 is recharged by a perched water condition), and other wells drilled in unweathered bedrock underlying the northern extension of the west ridgeline (in the low flow zone) recharge very slowly from relatively isolated fractures. Therefore, the west ridgeline is believed to form a groundwater flow barrier.

The line of wells across the mouth of Gregory Canyon inclusive of GLA-14 and GLA-12 (Figure 10C) spans two bedrock domains apparently reflecting two degrees of fracture interconnectivity. Those wells east of and including GLA-13 all show a response to drawdown of other wells in that group. In contrast, wells west of GLA-13 can be characterized as representing a low flow zone, and have not been shown to respond similarly. This does not suggest that the wells in the low flow zone are isolated from each other or from wells east of and including GLA-13, since the projected equipotential surface includes all of the well data. Rather it suggests that the fraction of connected fractures within the low flow zone is less than in the bedrock domain to the east, assuming no difference in the transmissivity of the fractures. While a smaller well spacing in the low flow zone could be utilized to identify a similar drawdown response, it is not necessary to place additional wells in the low flow zone to detect contaminant transport because all fractures are recharged from the same source.

A contour map of the piezometric surface in the bedrock aquifer was developed for the GCLF, based on the depth to water level measurements made on October 9, 2004 (Appendix C-1, Plate 1). Using standard contouring and the hydrogeologic data obtained from investigations conducted by GLA and others at the site, fracture flow below the equipotential surface is west northwest from the Gregory Mountain recharge area to Gregory Canyon; occurs largely in the weathered zone; and is bounded by unweathered tonalite under the west ridgeline. The groundwater flow direction is effectively parallel to the groundwater flow barrier.

As shown in Table 12C, more recent groundwater level measurements recorded for these wells between December 1996 and October 2004 show no significant variations in the piezometric surface, although an overall decline in the water levels is recognized associated with a long-term regional drought. Therefore, it is concluded that the groundwater flow in the canyon is consistent over time and is thus predictable. For additional information, refer to the Geologic, Hydrogeologic, and Geotechnical Investigation report included in Appendix C, and the Supplemental Hydrogeologic Investigation Report (GLA, 2004) included in Appendix C-1.

Springs

Based on visual reconnaissance of the project site and review of the USGS 7.5-minute topographic maps (Pala and Bonsall quadrangles), there are no springs within one mile of the project boundaries. Although no permanent springs have been identified in Gregory Canyon, the vigorous development of riparian vegetation along the thalweg of the canyon, and its main tributaries, suggests that the piezometric level of the underlying aquifer is close to the surface along the lowest points of the canyon.

TABLE 12C
SITE MONITORING WELL INFORMATION
GREGORY CANYON LANDFILL

(TABLE 12C IS 11"X17" IN SIZE AND IS INCLUDED AS SEPARATE PDF FILE)

D.5.2 GROUNDWATER QUALITY

Regional Groundwater Quality. Water quality data for wells in the Pala Hydrologic Subarea are sparse. One key indicator of groundwater quality is the total dissolved solids (TDS) concentration. As a result, for aesthetic reasons (i.e., taste, odor, appearance), the state has recommended that the TDS concentration be no greater than 500 mg/l in drinking water supplies. Currently, TDS concentrations in SDCWA imported supplies range from about 500 to 700 mg/l (SDCWA, 1997). Based on available groundwater quality data, the alluvial aquifer in the Pala Basin is good, with groundwater concentrations of TDS estimated in the range of 200 to 860 mg/l (J.A. Moreland, 1974) compared with 600 to 3,400 mg/l TDS for the Bonsall Basin. The average TDS concentration for the Pala Basin is estimated to be 600 mg/l (NBS Lowry, 1995).

Local Groundwater Quality. A limited water quality evaluation was performed in August 1999 from on-site monitoring wells, residential/production wells, and the San Luis Rey River to assess the groundwater quality in the vicinity of the project site. Specifically, samples were obtained from upgradient monitoring wells GLA-4 and GLA-5 and downgradient wells GLA-2, GLA-7 and GLA-10 (Figure 10). Three residential/production wells were also sampled within the San Luis Rey River valley. One residential well (Verboom Well No. 5) is located on the west side of the site near the Verboom residence, the second residential well coincides with the SLRMWD well #34, and the third residential well is Lucio Well #2, located on the north side of the river on the Lucio Family Dairy property. The samples were analyzed for the indicator parameters (chloride, nitrate as nitrogen, pH, sulfate, TDS and volatile organic compounds [by EPA Method 8260]).

TDS in groundwater samples collected from wells sited within Gregory Canyon during the August 1999 sampling event ranged from 444 mg/l to 992 mg/l. Only the groundwater sample from upgradient well GLA-4 (444 mg/l) actually met the state recommended maximum contaminant level (MCL) of 500 mg/l TDS for drinking water and beneficial groundwater use area designation (RWQCB, 1994). It should be noted that water delivered by the San Diego County Water Authority and its member agencies to users throughout the County has typical TDS concentrations ranging between 500 and 700 mg/l. Therefore, with respect to this parameter, the groundwater resource at Gregory Canyon can be considered average for San Diego County. In addition, samples collected from upgradient (background) well GLA-5 contained concentrations of nitrate as nitrogen (16.6 mg/l) and sulfate (306 mg/l) above the state recommended MCLs of 10 mg/l and 250 mg/l, respectively. Downgradient well GLA-2 contained the highest concentrations of nitrate as nitrogen (26.2 mg/l) and also exceeded the state and federal MCLs for this constituent. Based on a review of these 1999 groundwater quality data, they are generally consistent with those obtained from earlier water quality studies.

D.5.3 MONITORING REQUIREMENTS

The groundwater monitoring program to be conducted at the GCLF will comply with 27 CCR, Article 1 requirements as implemented through the WDRs issued by the San Diego RWQCB. The groundwater monitoring system is described in detail in Section B.5.1.3 and the M&RP is included in Appendix G.

As part of the permitting process for the GCLF, and in accordance with 27 CCR §20415 (e)(6), beginning in December 2000, GLA collected quarterly groundwater and surface water samples from both background and compliance sampling locations to assist in the development of a data base on the water quality at least one year prior to landfilling operations at the GCLF. In addition, monthly water level data were obtained over a one year period to establish the highest and lowest expected water levels for the site. Table 12C provides the available water level data.

The sampling program included collection of samples from the bedrock aquifer in upgradient (background) wells GLA-4, GLA-5, and GLA-11, and downgradient (point-of-compliance) wells GLA-2, GLA-10, GLA-12, GLA-13, and GLA-14, and from the alluvial aquifer in background (upgradient) well Lucio #2, and downgradient alluvial wells GLA-16, and SLRMWD designated well #34. Surface water samples were collected in the San Luis Rey River from surface water stations SLRSW-1 (upstream of Gregory Canyon) and SLRSW-2 (downstream of Gregory Canyon). Samples collected from each of these sample points were analyzed for the full suite of constituents of concern (COCs) provided in the Code of Federal Regulations (40 CFR Part 258, Appendix II). Included in this list of compounds are cyanide, sulfide, 20 metals, VOCs, semivolatile organic compounds (SVOCs), chlorinated herbicides, pesticides and polychlorinated biphenyls (PCBs). In addition, samples were submitted for the metal surrogates including chloride, nitrate, sulfate, pH, and TDS.

In evaluating general water quality, the median values obtained from the four quarters of data (and the August 1999 water quality data if available) for each constituent were compared with currently established state and federal MCLs and San Diego RWQCB Basin Objectives. Review of the median data indicates similar water quality to the data obtained earlier. Median concentrations of chloride, TDS and nitrate in some bedrock wells were measured above the upper state MCL, while water quality in the alluvial wells was found to meet state and federal MCLs and the local basin objectives. Comparison of the surface water sample data with currently established state and federal MCLs and surface water basin objectives indicates that only the median TDS concentrations in both surface water samples exceeded the basin objective.

In the bedrock aquifer, comparison of the median data across the site indicates that samples from upgradient (background) wells GLA-4 and GLA-11 contained some of the lowest concentrations of most of the general chemistry constituents and several metals. Samples from downgradient well GLA-2 contained several general chemistry and metals at the highest concentrations in the bedrock aquifer wells. The samples from background well GLA-5, located at the head of the canyon, contained elevated concentrations of nitrate and TDS, and the highest concentrations of sulfate and barium compared with the other bedrock aquifer wells. For the alluvial aquifer, the groundwater data is relatively consistent between the three sampled wells, with slightly lower concentrations measured in SLRMWD well #34. In the surface water, review of the data indicated very little difference between the median values up and downstream of the canyon. This finding is not surprising considering the relatively undisturbed nature of the area.

Review of COC data demonstrate that no pesticides or PCBs were detected in groundwater at the Gregory Canyon site, and only one chlorinated herbicide (2,4-D) was identified once and at a trace concentration in the sample from downgradient bedrock well GLA-13. In contrast, several VOCs and SVOCs were detected one or more times in the groundwater monitoring system samples. The majority of the detected VOCs and SVOCs are either common laboratory compounds such as acetone, carbon disulfide, chloroform, and phthalates or are constituents in hydrocarbon-based fuel (such as benzene, toluene, ethylbenzene and xylenes). Three VOCs were detected in surface water samples (acetone, carbon disulfide and toluene) and only in the upstream sample. Because the data obtained to date suggest only sporadic detections of organic compounds, those identified are often attributed to laboratory/field-introduced impacts, and there are few on-site sources for these compounds, laboratory or field contamination is suspected. This conclusion will be confirmed during future quarterly sampling events (scheduled to begin following construction of the monitoring system to be conducted during the spring 2004) that will be required prior to and during development of the landfill.

D.5.4 SLRMWD AGREEMENT

On April 15, 1996, an agreement was executed by the proponents of the GCLF, the SLRMWD, and several private landowners located downstream of the landfill project. The purpose of the agreement is to ensure that the construction, operation, and closure of the GCLF project are carried out in a manner that will help protect the quality of the water in the Pala Basin, and thus, the other downgradient basins of the San Luis Rey River.

Provisions outlined in the landfill agreement include stipulations that address the protection of water supply, water rights, groundwater monitoring, liability, and closure. More specifically, Section 5(a) of the agreement stipulates that water quality reports be provided to the SLRMWD within ten days of receipt of the water quality monitoring results. Section 5(b) addresses the leachate monitoring system and requires that the applicant coordinate with the SLRMWD concerning the number, specifications, location, and frequency of data collection at the monitoring stations. Section 6(c) requires that a reverse osmosis treatment facility be included to provide a groundwater treatment facility that is in place in the event that groundwater impacts are identified. Finally, Section 9(a) addresses financial assurances and cost estimates.

In a more recent (September 20, 2004) letter, the agreement was amended to include a collaborative effort between proponents of GCLF and the SLRMWD to develop protocols for collection, handling and analysis of groundwater samples, with the SLRMWD selecting the contractors to perform those services, Gregory Canyon Ltd. will be required to make the arrangements with the selected contractors to perform these services at its expense. A copy of the First Supplement to the SLRMWD Agreement (dated June 30, 2004) is included in Appendix Q.

D.5.5 AQUEDUCT RELOCATION OPTION

It is anticipated that a portion of the existing First San Diego Aqueduct (also known as Pipelines No. 1 and 2) will be relocated further west of the landfill footprint on the western side of the canyon ridge. A new pipeline (Pipeline No. 6) is also proposed at this westerly location. Whether or not the pipelines are relocated, groundwater monitoring will be conducted to ensure that there are no impacts to groundwater or surface water adjacent to these pipelines.

D.5.6 WATER USAGE

Existing beneficial uses and water quality objectives have been established by the RWQCB (1975 and 1994) for surface and groundwater in the vicinity of Gregory Canyon. The GCLF is located in the San Diego Hydrologic Basin. A Basin Plan was initially approved by the SWRCB in March 1975 and an update to the Plan was drafted in 1994 (RWQCB 1994). Beneficial uses of surface water in the Pala Hydrologic Subarea include municipal or domestic, agricultural, and industrial service supply. However, because surface water is generally seasonal and the supply is unreliable, beneficial uses for municipal and industrial service supply are restricted. In addition, surface waters provide beneficial uses for water- and non-water-contact recreation. Despite the unreliability of surface water, it provides a water supply to vegetation and maintains wildlife habitats. Surface water in the Pala Hydrologic Subarea provides warm- and cold-water habitats to sustain aquatic organisms.

Traditionally the Pala Basin groundwater has been used for agricultural and livestock purposes, although more recently a few commercial materials companies have been established in the basin. The Pala basin groundwater provides nearly all of the potable water supply for the Pala Indian Reservation (upgradient of the landfill), the SLRMWD (downgradient of the landfill), and for other municipal and agricultural purposes in the basin (NBS Lowry, 1995). It is anticipated that the Pala Basin groundwater will continue to be used for municipal and agricultural uses in the future. The SWRCB has established general water quality objectives whereby existing water quality superior to the established water quality objectives is to be maintained unless provided for otherwise by SWRCB Resolution No. 68-16.

The locations of known off-site wells in the vicinity of Gregory Canyon were investigated as part of the Phase 5 Hydrogeologic Investigation (GLA, 1997). To supplement this survey, water well Drillers Reports were obtained from the State Department of Water Resources to locate all wells within one mile outside of the facilities boundaries in accordance with 27 CCR, Section 21750(h)(1). Facility boundary is defined as the boundary surrounding the entire area on which solid waste facility activities occur and are permitted. Figure 30A shows the off-site wells identified within one mile of the GCLF boundaries. Table 12D provides a summary of the well information for these wells. However, it should be noted that unlike the 1997 survey, field verification was not performed as part of this supplemental well search.

The largest concentration of wells is in the alluvial basin of the San Luis Rey River, with a few additional wells serving dwellings and orchards in Rice and Couser Canyons. According to the operators of orchards south of Gregory Canyon that were interviewed in 1997, irrigation water for these orchards is derived primarily from the First San Diego Aqueduct and not from wells.

Several SDCWA member agencies and other water agencies have either implemented groundwater projects or are planning or evaluating potential projects to develop potable water supply within the San Luis Rey River Basin. Within the Lower San Luis Rey River Hydrologic Area, the City of Oceanside is extracting 2,200 AFY of groundwater from the Mission Basin and that project is being expanded to include an additional 4,900 AFY of potable water supply. A conceptual project has been identified by the City of Oceanside to expand groundwater development in the Mission Basin by an additional 15,300 AFY of supply. In addition, the Rainbow Municipal Water District is evaluating the development of 3,000 AFY of potable supply from the Bonsall Basin. For the Monserate Hydrologic Area, in which Gregory Canyon is located, the Yuima Municipal Water District is pumping up to 2,700 AFY from the Pauma Basin (SDCWA, 1997).

SDCWA assigned a high score to the Pala/Pauma Basins, along with several other groundwater basins and surface reservoirs, during its initial "Regional Screening of New Sources of Water." Accordingly, these basins were targeted for further analysis under the "Analysis of Alternatives." However, the resulting analysis of alternatives ranked the Pala/Pauma groundwater basins in a lower group (less attractive), and therefore they were not considered further as a viable

TABLE 12D
WATER WELLS WITHIN ONE MILE OF
THE GREGORY CANYON LANDFILL

CONFIDENTIAL (NOT FOR PUBLIC DISTRIBUTION) new source of water. Primary reasons for the low ranking included very low groundwater elevations that would require extensive pumping facilities for water conveyance, relatively little emergency storage capacity, and the need for extensive infrastructure including wells and connecting pipelines throughout the basin (SDCWA, 1997). As stated above, the Bonsall Basin is being considered for development by the Rainbow Municipal Water District to provide an additional 3,000 AFY of potable water supply.

SECTION D.6

REFERENCES AND RESOURCES

D.6 REFERENCES AND RESOURCES

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